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Powerful Sensing Solutions for a Better Life

# CRM500GA-[]
# Installation Manual

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## Revision History

| Revision | Date | Author | Comments |
|---|---|---|---|
| -01_A | 12/17/04 | GB | Initial Release |
| -01_B | 12/22/04 | DIP | Corrected wiring diagram pin-out. |
| -02_A | 2/3/05 | GB | Updated address, wiring diagram and MagAlign. |
| -03_A | 8/05 | GB/DIP | Updated MagAlign. |
| -03_B | 2/07 | MPS | Added Usage Clause |
| -03_C | 1/09 | MPS | Updated Parts List<br>Install drawing updated to reflect additional mounting holes. |
| -03_D | 11/09 | PAL | Added AHRS500GA-32x to list of model #'s compatible w/ CRM500 per ECO 1312 |

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# 1 About this Manual

## 1.1 Notation

The designation CRM500GA-[] denotes that the family of CRM500GA products and the topic is common to all models identified by dash number. Instances where the dash number is called out, i.e., CRM500GA-200, indicate a topic that pertains only to the particular model of the CRM500GA called out by the dash number.

The CRM500GA-[] can be used in conjunction with the following AHRS500 model number and part numbers.

| | |
|---|---|
| AHRS500GA-220 | p/n 8350-0260-03 or higher dash number |
| AHRS500GA-221 | p/n 8350-0261-03 or higher dash number |
| AHRS500GA-222 | p/n 8350-0262-03 or higher dash number |
| | p/n 8360-0262-03 or higher dash number |
| AHRS500GA-223 | p/n 8350-0263-03 or higher dash number |
| | p/n 8360-0263-04 or higher dash number |
| AHRS500GA-224 | p/n 8350-0264-03 or higher dash number |
| AHRS500GA-225 | p/n 8350-0265-03 or higher dash number |
| AHRS500GA-226 | p/n 8350-0266-03 or higher dash number |
| AHRS500GA-227 | p/n 8350-0267-03 or higher dash number |
| AHRS500CA-220 | p/n 8350-0250-03 or higher dash number |
| AHRS500CA-222 | p/n 8350-0252-03 or higher dash number |
| | p/n 8360-0252-03 or higher dash number |
| AHRS500CA-224 | p/n 8350-0254-03 or higher dash number |
| AHRS500GA-320 | p/n 8350-0270-01 or higher dash number |
| AHRS500GA-321 | p/n 8350-0271-01 or higher dash number |
| AHRS500GA-322 | p/n 8350-0272-01 or higher dash number |
| AHRS500GA-323 | p/n 8350-0273-01 or higher dash number |
| AHRS500GA-324 | p/n 8350-0274-01 or higher dash number |
| AHRS500GA-325 | p/n 8350-0275-01 or higher dash number |
| AHRS500GA-326 | p/n 8350-0276-01 or higher dash number |
| AHRS500GA-327 | p/n 8350-0277-01 or higher dash number |

# 2 Introduction

## 2.1 Purpose

This manual describes installation of the CRM500GA-[] MEMSIC Remote Magnetometer (CRM). It is intended for use by personnel certified by the Federal Aviation Administration (FAA) to install aircraft navigation devices. It includes installation, alignment, and checkout procedures.

## 2.2 Reference Documents

Applicable Aircraft Maintenance Manuals

FAA Advisory Circular AC 43.13-1B

## 2.3 The CRM500GA-[] System Description

The CRM500GA-[] remote magnetometer is a three Degree-of-Freedom (DOF) strap down earth magnetic field measurement reference system.

The CRM500GA-[] in conjunction with an AHRS500GA (-220 or higher) is the solid-state equivalent of a vertical gyro combined with directional gyro. The CRM500GA-[] uses three solid-state magnetometers, three solid state accelerometers, and high speed digital microprocessor based electronics to provide the earth magnetic field 3 dimensional vector, which can then be used to calculate a heading reference. The three-axis magnetometer is mounted on an internal circuit board, and attached with the other electronics. The three-axis accelerometer is used for attitude leveling of the CRM500GA-[] mounting location. The CRM500GA-[] remote magnetometer provides an accurate measure of the earth magnetic field which is used as a heading reference in avionic dynamic environments including altitude, temperature, shock, and vibration. The CRM500GA-[] remote magnetometer is designed to be located in the portions of the aircraft where pressure and temperature are not controlled.

## 2.4 CRM500GA-[] Coordinate Systems

The CRM500GA-[] uses the coordinate system as defined in the Installation Drawing (Appendix section 8.1). The CRM500GA-[] needs to be installed in such a way that the arrow points to the front of the aircraft.

The axes form an orthogonal right-handed coordinate system. Acceleration is negative when it is oriented towards the positive side of the coordinate axis. For example, with the CRM500GA-[] sitting on a level table, it will measure zero g along the x- and y-axes and +1 g along the z-axis. Gravitational acceleration is measured upward, and thus with the positive axis for the CRM500GA-[] facing downward, resulting in a positive +1g for

the CRM500GA-[] z-axis. The magnetic sensors are aligned with the same axes definitions and sign as the linear accelerometers.

## 2.5 Data Interface

The CRM500GA-[] serial interface is standard RS-422, 38400 baud, 8 data bits, 1 start bit, 1 stop bit, no parity, and no flow control, and will output at 50 Hz. This needs to be directly interfaced to the AHRS500GA (-220 or higher).

## 2.6 Magnetic Heading

Magnetic north is the direction toward the magnetic north pole; true north is the direction towards the true North Pole. The CRM500GA-[] earth magnetic vector can be used to calculate a heading angle that is referenced to magnetic north. The direction of true north will vary from magnetic north depending on your position on the earth. The difference between true and magnetic north is called declination or magnetic variance. You will need to know your declination to translate the calculated magnetic heading generated from the CRM500GA-[] earth magnetic field vector into a heading referenced to true north.

## 2.7 Major System Components

In addition to the CRM500GA-[] sensor product and the CRM500GA-[] Installation Manual you should have:

- **1 CD with MEMSIC MagAlign Software**

  AHRS500 and CRM500 Installation MagAlign software will allow you to align the magnetometers on the CRM500GA-[] on a PC running Microsoft® Windows™. You can also download this software from MEMSIC's web site at http://www.xbow.com.
- **CRM500GA-[] Installation Drawing** (also included in Appendix section 8.1 of this manual)
- **CRM500GA-[] Installation Wiring Diagram** (also included in Appendix section 8.2 of this manual)
- **1 CRM500GA-[] Series Operator's Manual**

  This contains valuable operating instructions including limitations.
- **1 Mating connector and backshell**

  The mating connector and backshell are to be used to interconnect with the CRM500GA-[].
- **1 set of Mounting Hardware**

  Size #6 non-magnetic screws, nuts and washers are provided for installation of the CRM500GA-[].

## 2.8 Unpacking the Equipment

Carefully unpack the equipment and verify all the major system components have been received. Visually inspect the package contents for any evidence of shipping damage. Retain the shipping container and packaging material in case reshipment is necessary.

## 2.9 General

The installation technicians should thoroughly familiarize themselves with the installation drawing and installation wiring diagrams prior to installation of the CRM500GA-[].

## IMPORTANT

The CRM500GA-[] should not be exposed to large magnetic fields. This could permanently magnetize internal components of the CRM500GA-[] and degrade its magnetic heading accuracy.

# 3 Limitations

## 3.1 Environmental Conditions

The CRM500GA-[] is limited to operation in the DO-160D environmental conditions marked on the unit label and are also listed in Table 2. The D2 temperature and altitude category is limited to an operating low temperature of –55ºC, an operating high temperature limit of +70ºC, and a short term operating high temperature limit of +70ºC.

TYPE/MODEL/PART NO: CRM500GA-[]

TSO NUMBER: TSO-C6d

MANUFACTURER: MEMSIC, Inc.

ADDRESS: 1759 McCarthy Blvd, Milpitas, CA 95035

REVISION AND CHANGE NUMBER OF DO-160: D

**Table 1. DO-160D environmental conditions**

| CONDITIONS | SECTION | DESCRIPTION OF TESTS CONDUCTED | IDENT |
|---|---|---|---|
| Temperature & Altitude | 4.0 | Equipment tested to D2 | D2 |
| Ground Survival Low Temperature | 4.5.1 | Equipment tested to –55ºC | D2 |
| Op Low Temperature | 4.5.1 | Equipment tested to –55ºC | D2 |
| Ground Survival High Temperature | 4.5.2 | Equipment tested to +85ºC | D2 |
| Short-time Op High Temperature | 4.5.2 | Equipment tested to +70ºC | D2 |
| Op High Temperature | 4.5.3 | Equipment tested to +70ºC | D2 |
| In-Flight Loss of Cooling | 4.5.4 | Equipment requires no cooling air | D2 |
| Altitude | 4.6.1 | Equipment tested to 50,000 ft | D2 |
| Decompression | 4.6.2 | Not Applicable | X |
| Overpressure | 4.6.3 | Not Applicable | X |
| Temperature | 5.0 | Equipment tested to | B |

| | | | |
|---|---|---|---|
| Variation | | Category B | |
| Humidity | 6.0 | Equipment tested to Category B | B |
| Operational Shock and Crash Safety | 7.0 | Equipment tested to Category B | B |
| Vibration | 8.0 | Equipment tested to Category T for fixed wing fuselage and instrument panel and equipment rack; Curves E, E1, P<br>Category U for unspecified helicopter; Curves F, F1 | (TEE1P)<br>(UFF1) |
| Explosion | 9.0 | Equipment identified as Category X, no test performed | X |
| Waterproofness | 10.0 | Equipment tested to Category W | W |
| Fluids Susceptibility | 11.0 | Equipment identified as Category X, no test performed | X |
| Sand and Dust | 12.0 | Equipment identified as Category X, no test performed | X |
| Fungus | 13.0 | Equipment identified as Category X, no test performed | X |
| Salt Spray | 14.0 | Equipment tested to Category X, no test performed | X |
| Magnetic Effect | 15.0 | Equipment tested to Category Z | Z |
| Power Input | 16.0 | Equipment tested to Category B | B |
| Voltage Spike | 17.0 | Equipment tested to Category A | A |
| Audio Frequency Susceptibility | 18.0 | Equipment tested to Category B | B |

| | | | |
|---|---|---|---|
| Induced Signal Susceptibility | 19.0 | Equipment tested to Category C | C |
| Radio Frequency Susceptibility | 20.0 | Equipment tested to Category W | WWW |
| Radio Frequency Emission | 21.0 | Equipment tested to Category M | M |
| Lightning Induced Transient Susceptibility | 22.0 | Equipment tested to Category A3G33 | A3G33 |
| Lightning Direct Effects | 23.0 | Equipment identified as Category X, no test performed | X |
| Icing | 24.0 | Equipment tested to Category A | A |
| Electrostatic Discharge | 25.0 | Equipment tested to Category A | A |

## 3.2 Large Magnetic Field Exposure

The CRM500GA-[] should not be exposed to large magnetic fields. This could permanently magnetize internal components of the CRM500GA-[] and degrade its magnetic heading accuracy. DO NOT stick a magnet to the CRM500GA-[].

## 3.3 Mechanical and Vibration

The CRM500GA-[] must be installed in a location that is rigid to alleviate potential vibration errors induced from normal airframe vibration sources.

The mounting plate must be stiff enough to rigidly follow the aircraft motions without inducing low frequency motions relative to the aircraft.

## 3.4 Magnetic Environment

The CRM500GA-[] uses a set of sensitive magnetometers inside its housing to measure Earth's weak magnetic field, which is then used by the AHRS500GA-220 or greater to determine heading. As a result, small amounts of moving magnetic material near the CRM500GA-[] can have large effects on the heading calculation.

The CRM500GA-[] should be isolated from magnetic material as much as possible. Magnetic material will distort the magnetic field near the CRM500GA-[], which can affect its accuracy as an earth magnetic field sensor.

Materials to avoid include anything that will stick to a magnet: iron, carbon steel, some stainless steels, nickel and cobalt. Use a magnet to test materials that will be near the CRM500GA-[]. Code within the AHRS500GA (-220 or higher) can correct for the effect of these magnetic fields by using hard and soft iron alignment routine as long as the material is stationary.

Materials that will not affect the magnetic heading performance include aluminum, brass, plastic, titanium, wood, and some stainless steels. Again, if in doubt, try to stick a magnet on the material. If the magnet doesn't stick, you are working with a material that will not affect the heading.

The alignment procedure will compensate for stationary ferrous objects. Moving ferrous objects located within 24 inches of the CRM500GA-[] cannot be fully compensated for by the magnetometer alignment. For this reason the CRM500GA-[] must not be located within 24 inches of any large moving ferrous metal objects such as landing gear components, electric motors, control linkages, etc. Ferrous metal objects that may change position during flight operations, such as landing gear, flap actuators, and control linkages must also not be within 24 inches of the CRM500GA-[].

The CRM500GA-[] should not be located close to high current DC power cables or 400 cycle AC power cables and their associated magnetic fields.

## 3.5 CRM500GA-[] Alignment with the aircraft

The CRM500GA-[] must be level on the yaw and roll planes of rotation when the aircraft is in straight and level flight. The pitch axis must be level to the aircraft when aircraft is leveled for weight and balance measurements.

The CRM500GA-[] will measure gravity and the earth magnetic field vector along the axes of its sensors. The CRM500GA-[] sensors are aligned with the baseplate. The baseplate references are noted in the installation drawing and are used as reference surfaces for aligning the CRM500GA-[] sensor axes with the aircraft. The CRM500GA-[] should be aligned as closely as possible with the axes you define in your system. Errors in alignment will contribute directly to errors in measured earth magnetic field vector relative to your system axes.

It is important that the CRM500GA-[] be aligned carefully with the longitudinal axis of the aircraft and NOT with the outer skin of the fuselage.

# 4 CRM500GA-[] Installation Pre-Modification Procedures

This section describes the procedures to be used before final installation of the CRM500GA-[]. These procedures describe the installation location selection for the CRM500GA-[]. Always use good avionics installation practices per FAA Advisory Circulars AC43.13-1B, 4.13-2A, and AC20-138 or later FAA approved revisions of these documents.

## 4.1 Pre-Mod Avionics Test

Perform a pre-modification avionics systems test to verify that the systems that will be connected to the CRM500GA-[] are working properly in accordance with their appropriate maintenance manuals.

## 4.2 Mating Connector Crimp Tools

A crimp tool recommended by the mating tool manufacturer should be used to ensure consistent and reliable crimp contact connections for the mating connector.

## 4.3 Pre-Mod Load Review

Complete an electrical load analysis on the aircraft prior to installing the CRM500GA-[] to ensure the aircraft has the electrical load capacity to carry the new load.

## 4.4 Installation Location Selection

### *4.4.1 Introduction*

Selecting the location for the CRM500GA-[] is a two-step process.

- The first step is to find a “proposed” location based on the criteria in this section.
- The second step is using the CRM500GA-[] and the MagAlign software to survey the proposed location for magnetic interference from other aircraft systems.

### *4.4.2 Location and proximity to IDU (Integrated Display Unit)*

The CRM500GA-[] can be mounted inside or outside of the pressure vessel. Most aircraft can accommodate the CRM500GA-[] in the wings or near to any traditional compass mechanism installed on the aircraft (NOT THE INTERNAL COCKPIT COMPASS). Whether you want to place the

CRM500GA-[] there, or elsewhere, the location for the CRM500GA-[] must comply with the environmental specifications called out in section 3.

### *4.4.3 Mounting Structure*

The CRM500GA-[] must be installed in a location that is rigid to alleviate potential vibration errors induced from normal airframe vibration sources.

The mounting plate must be stiff enough to rigidly follow the aircraft motions without inducing low frequency motions relative to the aircraft. If you have any doubt concerning the CRM500GA-[] location suitability, please contact your MEMSIC technical representative by phone at (408) 964-9700, or visit our website at http://www.memsic.com.

### *4.4.4 Magnetic Environment Considerations*

#### 4.4.4.1 Materials

The CRM500GA-[] uses a set of sensitive magnetometers inside its housing to measure Earth's weak magnetic field which is then used by the AHRS500GA (-220 or higher) to calculate heading. The CRM500GA-[] should be isolated from magnetic material as much as possible. Magnetic material will distort the magnetic field near the CRM500GA-[], which can affect its accuracy as an earth magnetic field vector sensor. As a result, small amounts of moving magnetic material near the CRM500GA-[] can have large effects on the calculated heading measurement.

The alignment procedure will compensate for stationary ferrous objects. Moving ferrous objects located within 24 inches of the CRM500GA-[] cannot be fully compensated for by the magnetometer alignment. For this reason the CRM500GA-[] must not be located within 24 inches of any large moving ferrous metal objects such as landing gear components, electric motors, control linkages, etc. Ferrous metal objects that may change position during flight operations, such as landing gear, flap actuators, and control linkages must also not be within 24 inches of the CRM500GA-[].

Materials to avoid include anything that will stick to a magnet: iron, carbon steel, some stainless steels, nickel and cobalt. Materials that will not affect the magnetic heading performance include aluminum, brass, plastic, titanium, wood, and some stainless steels. Use a magnet to test materials that will be near the CRM500GA-[]. If the magnet doesn't stick, you are working with a material that will not affect the heading.

DO NOT stick a magnet to the CRM500GA-[].

# WARNING

For the CRM500GA-[] to function properly in a tubular steel fuselage aircraft, you must completely degauss the airframe prior to CRM500GA-[] installation.

# WARNING

It may be necessary to degauss flight control cables near the CRM500GA-[] location to prevent magnetic interference.

#### 4.4.4.2 Distance from moving ferrous (iron and steel) metallic objects

The CRM500GA-[] must not be located within 24 inches of any large, moving, ferrous metal objects such as landing gear components, motors, steel control cables or linkage. Avoid any metallic objects that may change position between ground operations and flight operations, such as landing gear, flap actuators, and control linkages.

#### 4.4.4.3 Distance from electrical wires

The CRM500GA-[] should not be located close to high current DC power cables or 400 cycle AC power cables and their associated magnetic fields. Wires carrying high currents, alternating currents, or intermittent currents can cause magnetic variations that will affect the CRM500GA-[]. Keep wires with these characteristics at least 24 inches away from the CRM500GA-[]. These wires can include:

Battery wires

Strobe wires

Autopilot control wires

Position light wires

De-ice boot wires

Air conditioning power wires

HF control wires

### *4.4.5 CRM500GA-[] Alignment with the aircraft*

The CRM500GA-[] will measure gravity and the earth magnetic field vector along the axes of its sensors. The CRM500GA-[] sensors are aligned with the baseplate. The baseplate references are noted in the installation drawing and are used as reference surfaces for aligning the CRM500GA-[] sensor axes with the aircraft. The CRM500GA-[] should be aligned as closely as possible with the axes you define in your system. Errors in

alignment will contribute directly to errors in measured acceleration and rotation relative to your system axes.

#### 4.4.5.1 Attitude Leveling

The CRM500GA-[] must be level on the yaw and roll planes of rotation when the aircraft is in straight and level flight. The pitch axis must be level to the aircraft when aircraft is leveled for weight and balance measurements.

#### 4.4.5.2 Longitudinal Alignment

The arrow on CRM500GA-[] must face front of the aircraft.

It is important that the CRM500GA-[] is properly aligned with the longitudinal axis of the aircraft and NOT with the fuselage skin. The alignment of the CRM500GA-[] baseplate and the longitudinal axis must be within 0.5 degree for proper operation.

## WARNING

The CRM500GA-[] must be aligned parallel to the centerline of the aircraft. Failure to align the CRM500GA-[] parallel to the aircraft centerline will cause errors in heading that cannot be corrected.

### *4.4.6 Survey the Location for Magnetic Interference*

The CRM500GA-[] may be used to survey the proposed location for magnetic interference by other aircraft systems. The procedure uses the CRM500GA-[], located in the proposed location, and a laptop computer to survey the magnetic environment.

Temporarily mount/locate the CRM500GA-[] in the proposed location.

Connect the CRM500GA-[] using the alignment maintenance cable

Use the AHRS500 and CRM500 MagAlign software to assess heading changes while operating the aircraft subsystems with the aircraft facing one of the ordinal directions N, S, E, or W. Repeat with the aircraft rotated 90 degrees to another ordinal direction. Use the MagAlign software to determine the best location of the CRM500GA-[] by selecting the Navigation Window and viewing the heading deviations as systems around the CRM500GA-[] are activated, deactivated, and operated throughout their functions. A good location will not display more than a 4° heading change when all systems are operated. Systems should include operation of flaps, landing gears, and engines.

#### 4.4.6.1 Step 1: Temporarily mount the CRM500GA-[] in the proposed location.

#### 4.4.6.2 Step 2: Install the AHRS500 and CRM500 MagAlign Software on a portable computer

The computer should be a portable "laptop" style if possible with a serial port and Windows 98/NT4/2000/XP type operating system. The following are minimum capabilities that your computer should have to run the AHRS500 and CRM500 Installation MagAlign successfully:

CPU: Pentium-class

RAM Memory: 32MB minimum, 64MB recommended

Hard Drive Free Memory: 15MB

Operating System: Windows 98, NT4, 2000, XP

Freely available RS-232 compatible Serial Port

National Instruments Driver: LabVIEW RunTime Engine 6.1, which comes with CRM500 Installation MagAlign software.

To install AHRS500 and CRM500 Installation MagAlign Software in your computer:

1. Insert the CD "AHRS500 and CRM500 Installation MagAlign" in the CD-ROM drive.
2. Find the Installer folder. Double click on the setup.exe file.
3. Follow the setup wizard instructions. You will install AHRS500 and CRM500 Installation MagAlign and a LabVIEW Runtime Engine. You will need both these applications.

#### 4.4.6.3 Step 3: Alignment Cable Connections

The AHRS500GA-[] is shipped with an installation and alignment cable to connect the unit to a PC communications port.

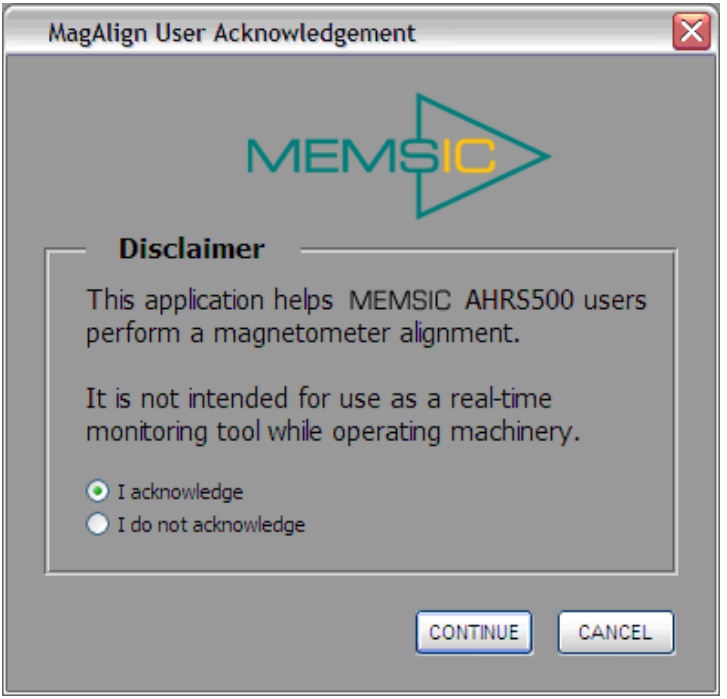
1. Connect the 15-pin female end of the alignment cable to the port on the AHRS500GA-[].
2. Connect the 15-pin male end of the alignment cable to the aircraft cable connector which supplies power to the AHRS500GA-[] and provides the CRM500GA-[] RS422 interface signals.
3. Start the computer before connecting the 9-pin end of the cable to the serial port of the computer. Later versions of Windows, especially Windows 2000 and Windows XP, interpret a connection to the serial port at boot time as a serial mouse. The operating system will load the mouse driver and interpret the data from the

AHRS500GA-[] as mouse commands if the AHRS500GA-[] is connected before the computer is started and booted.

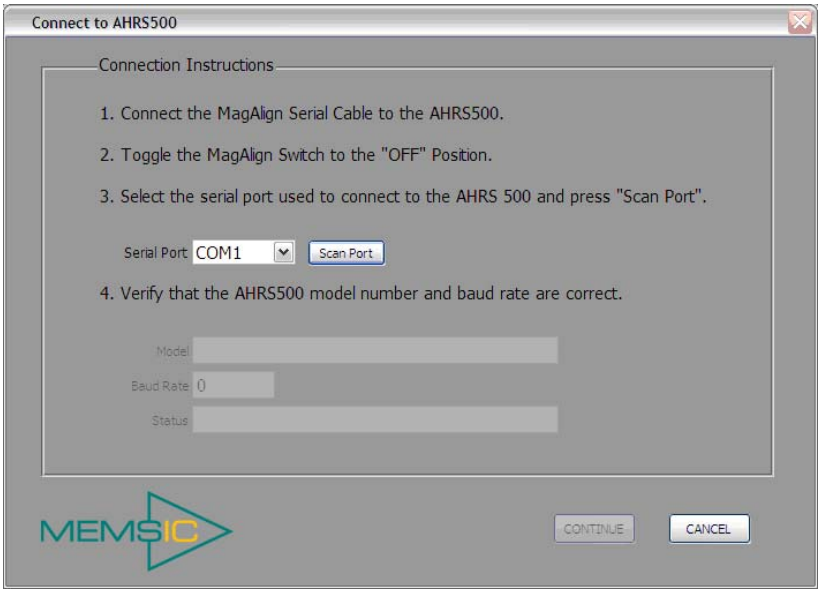
4. Connect the 9-pin end of the cable to the serial port of your computer.
5. The alignment switch on the cable should be set to OFF. Powering up the unit with the switch in the ON position will erase the magnetometer alignment.
6. Apply power and let the AHRS500GA-[] initialize for 90 seconds.
7. With the AHRS500GA-[] connected to your PC serial port and powered, open the AHRS500 and CRM500 Installation MagAlign software.

#### 4.4.6.4 Step 4: MagAlign Initialization

Upon opening the AHRS500 and CRM500 MagAlign software, the following disclaimer screen appears. Please read the disclaimer, and click on "I acknowledge" to Continue further.



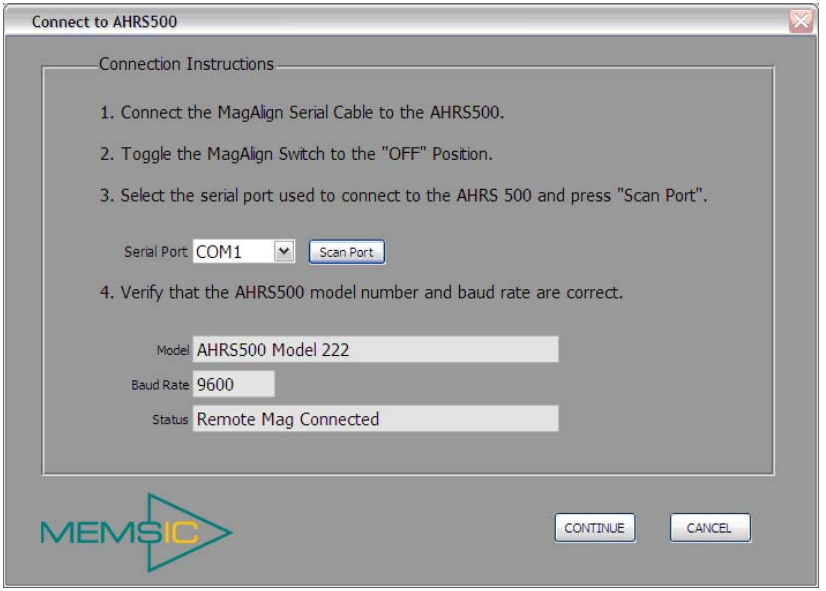
Once you acknowledge the disclaimer and click on “CONTINUE”, the “Connection Instructions” dialog window pops up, reminding users of basic steps before using the software. The screen is shown as follows:




After 3 seconds, an “Instructions” dialog window pops up, reminding users of basic steps before using the software. The screen is shown as follows:

The dialogue leads the user to an important step of connecting AHRS500GA-[] to the computer’s serial port. Double-check the serial port so that it matches with what you select on the screen. Incorrect serial port setting will result in non-response from the program. With proper COM port selected, click on “SCAN PORT”.

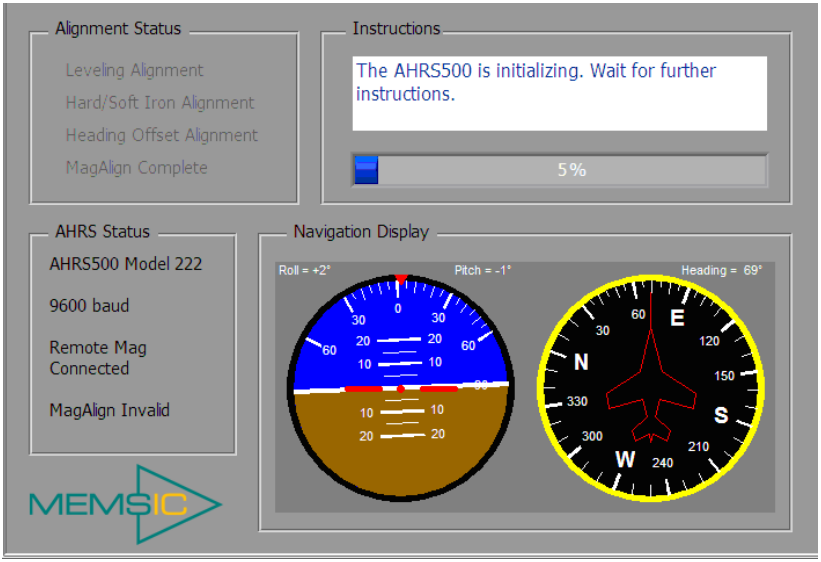
This should automatically detect the model number of the AHRS500GA-[] connected, display Baud Rate and the status of Remote Magnetometer Connection. If no Remote Magnetometer is connected, you should see “Remote Mag Connected” as shown below.




## ☞ IMPORTANT

If the Status reads “Remote Mag Not Connected”, then go back and check all your connections before proceeding further.

After hitting the “CONTINUE” button, the MagAlign brings up the Window showing Alignment Status, DMU Status, Instructions and Navigation Display Box as shown below. If the MagAlign software was started right after powering up the AHRS500GA-[], the Instructions will read “The AHRS500 is initializing. Wait for further instructions”.




#### 4.4.6.5 Step 5: Magnetic Environment Survey Process

The survey process will assess the affect of aircraft subsystems on the CRM500GA-[] earth magnetic field vector sensor performance. The heading display in the MagAlign software will be used to observe changes in heading as the aircraft subsystems are actuated.

##### *4.4.6.5.1 Point the aircraft to an ordinal heading*

If possible, align the aircraft along an ordinal heading of North, South, East or West. Precision alignment is not necessary. Make sure the AHRS500GA-[] has completed the 90 second initialization period. Observe the heading reading on the MagAlign software. ***Cycle mechanical subsystems and electrical subsystems that might interfere with the CRM500GA-[] heading while checking for*** heading errors. Move all control cables to their full extents and operate all equipment to ensure that there are no adverse affects to the CRM500GA-[] heading. An adverse affect would be a heading change of more than 4° at any time. A good location will not display more than a 4° heading change when all systems are operated. Systems can include operation of flaps, landing gears, and engines.

#### *4.4.6.5.2 Rotate the Aircraft through approximately 90 degrees*

Rotate the aircraft along an ordinal heading of North, South, East or West that is 90 degrees from the previous position. Precision alignment is not necessary. Make sure theAHRS500GA-[] has completed the 60 second initialization period. Observe the heading reading on the MagAlign software. ***Cycle mechanical subsystems and electrical subsystems that might interfere with the CRM500GA-[] heading while checking for*** heading errors. A good location will not display more than a 4° heading change when all systems are operated. Systems can include operation of flaps, landing gears, and engines. Repeat this for all the 4 ordinal heading directions (North, South, East and West) and ensure that satisfactory heading is obtained.

If the heading performance is not satisfactory, find a new location and repeat the tests.

# 5 CRM500GA-[] Installation Procedure

## 5.1 Task 1. Secure the CRM500GA-[] Wiring

The CRM500GA-[] must be mounted clear of any wiring bundles, strobe lines, antennas, or anything that may cause magnetic or electrical interference. Secure the wiring allowing access and movement of the CRM500GA-[] unit. Prepare, install, route, and terminate the connecting aircraft cable for the CRM500GA-[] in accordance with the CRM500GA-[] Installation Wiring Diagram (included in Appendix section 8.2 of this manual). Ensure the system wiring is routed separately from 400 cycle AC and high current DC power cables.

## 5.2 Task 2. Degauss Control Cables and Hardware

Degauss all control cables, attachment hardware, and other equipment located within a 24 inch area of the CRM500GA-[] unit using a hand-held degausser. Most audio and video degaussing units can be used.

## 5.3 Task 3. Permanently Mount the CRM500GA-[]

Find or manufacture a rigid mounting location of at least 0.040 inches (min) thick aluminum with sufficient stiffeners to alleviate potential vibration errors induced from normal airframe vibration (engine, control surfaces, etc.). Prepare a mounting plate in accordance with the CRM500GA-[] Installation drawing and in accordance with good practice and procedures for mounting to the aircraft structure. Secure the CRM500GA-[] unit to the airframe being careful to install all of the shims that were required to level on the yaw and roll planes of rotation when the aircraft is in a straight and level flight attitude. Use the non-ferrous hardware provided with the CRM500GA-[] where possible to reduce magnetic interference with the CRM500GA-[].

# 6 CRM500GA-[] Post Installation Procedures

## 6.1 Alignment Introduction

The CRM500GA-[] will need to be aligned for leveling, hard and soft iron compensation and heading offset before use with the aircraft. Mounting differences between the AHRS500GA (-220 or higher) and CRM500GA-[] can contribute to leveling and heading offset error, which must be accounted for in the AHRS500GA (-220 or higher) software. The CRM500GA-[] series provides an earth magnetic field vector measurement from internal magnetic sensors, which can then be used to compute heading. Ideally, the magnetic sensors would be measuring only earth's magnetic field as a means to provide data to compute the heading angle. In the real world, however, residual magnetism in the CRM500GA-[] itself and in your system will add to the magnetic field measured by the CRM500GA-[].

The extra magnetic field can create errors in the heading measurement if they are not compensated. These extra magnetic fields are called hard iron magnetic fields. In addition, magnetic material can change the direction of the magnetic field as a function of the input magnetic field. This dependence of the local magnetic field on input direction is called the soft iron effect. Code within the AHRS500GA (-220 or higher) measures any extra constant magnetic field that is associated with the CRM500GA-[] or your aircraft and corrects for it during the alignment procedure. The AHRS500GA (-220 or higher) can also make a correction for some soft iron effects. The process of measuring these non-ideal effects and correcting for them is called hard iron and soft iron alignment. Alignment will help correct for magnetic fields that are fixed with respect to the CRM500GA-[]. It cannot compensate for time varying fields, or fields created by parts that move with respect to the CRM500GA-[].

The CRM500GA-[] accounts for the extra magnetic field by making a series of measurements. The CRM500GA-[] uses these measurements to model the hard iron and soft iron environment in your aircraft.

## 6.2 CRM500GA-[] Magnetometer Alignment Procedure

The magnetometer alignment procedure is performed in place on the aircraft using the alignment/maintenance cable, a portable PC running Windows, and the AHRS500 and CRM500 Installation MagAlign software provided by MEMSIC, Inc. A switch on the cable provides a signal input to the AHRS500GA-[] commanding it to enter each mode of the alignment process. This will be apparent with the MagAlign PC software. During the first phase of alignment, the leveling alignment, the aircraft remains still. During the second phase of the alignment process, the hardiron/softiron

alignment, the aircraft will need to be rotated through a complete circle(s) while monitoring the AHRS500 and CRM500 Installation MagAlign software for progress. The alignment software will determine when an adequate set of alignment data has been acquired and notify the user through the Message Box. The entire procedure may take several rotations of the aircraft to collect sufficient data. During the third and final alignment phase (the heading offset alignment), the aircraft must be pointed as closely as possible to magnetic north.

It is required that you perform the alignment process with the CRM500GA-[] installed in your system. If you do the alignment process with the CRM500GA-[] by itself, you will only correct for the magnetism internal to the CRM500GA-[]. If you then install the CRM500GA-[] in an aircraft and the magnetic environment is different, you will still see errors arising from the magnetism of the aircraft environment.

### *6.2.1 Equipment Needed*

The following equipment and software is needed to perform the hard and soft iron alignment:

- **1 CD with AHRS500 and CRM500 Installation MagAlign Software**

  AHRS500GA-[] and CRM500GA-[] Installation MagAlign graphically displays the CRM500GA-[] output and provides step-by-step alignment instructions on a PC running Microsoft® Windows™. You can also download this software from MEMSIC's web site at http://www.memsic.com/support/documentation/inertial-systems/category/5-software-downloads.html.

- **1 Digital Signal Alignment/Maintenance Cable** (part number 8060-0140-01 included with AHRS500GA-[])

  The AHRS500 then connects to a PC running Microsoft Windows for installation and maintenance functions. Power is provided by the aircraft wiring harness but the serial output data stream from the CRM500GA-[] and AHRS500 is directed to the maintenance PC.

- **1 Portable computer**

  The computer should be a portable "laptop" style if possible with a serial port and Windows 98/NT4/2000/XP type operating system. The following are minimum capabilities that your computer should have to run the AHRS500 and CRM500 Installation MagAlign successfully:

CPU: Pentium-class

RAM Memory: 32MB minimum, 64MB recommended

Hard Drive Free Memory: 15MB

Operating System: Windows 95, 98, NT4, 2000, XP

Freely available RS-232 compatible Serial Port

National Instruments Driver: LabVIEW RunTime Engine 6.1, which comes with CRM500 Installation MagAlign software.

After finishing the steps aforementioned in Section 4.4.6, the program is ready to perform the alignment.

### *6.2.2 Alignment Process Overview*

There are several steps to the alignment process that are repeated until the AHRS500GA-[] has collected enough data to compute a hard and soft iron compensation that meets the performance requirements. The alignment steps are:

1. Apply power to the AHRS500GA-[] and CRM500GA-[]
2. Wait 90 seconds for initialization to complete
3. Turn the MagAlign switch ON
4. Maintain the aircraft position for 60 seconds for the Leveling Alignment to complete
5. Turn the MagAlign switch OFF
6. Turn the MagAlign switch ON and wait for 60 seconds for AHRS500GA-[] to re-initialize
7. Slowly rotate the aircraft through a full 360 degree turn until the software requests to stop the turn
8. Stop the turn
9. Wait 60 seconds for the AHRS500GA-[] to re-initialize
10. Repeat steps 7, 8 and 9 turning the aircraft through 360 degree circles with a wait between each turn, until the MagAlign Message Box indicates the alignment meets the performance requirements
11. Turn OFF the MagAlign switch to load the mag alignment data in the AHRS500GA-[]
12. Align the aircraft along the Magnetic North and turn the MagAlign switch ON
13. Maintain the position of the aircraft for 60 seconds for the heading offset calibration to complete

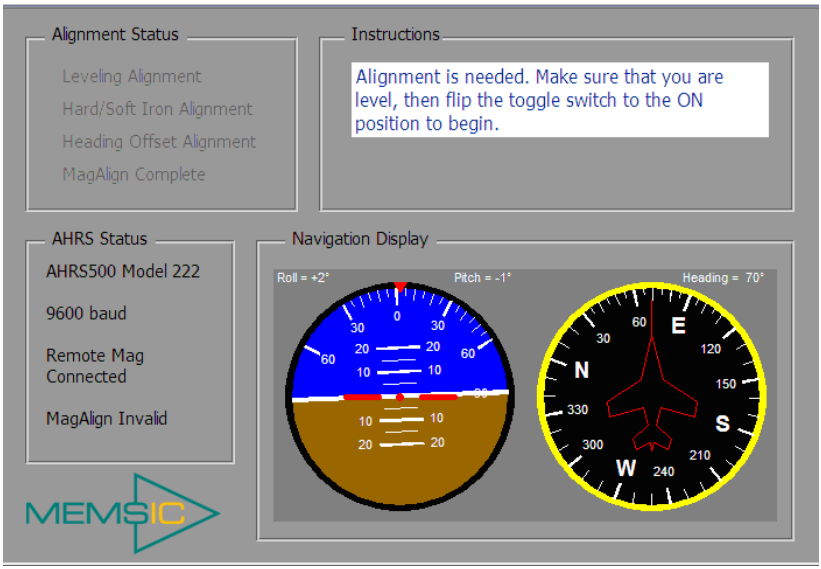
14. Upon completion wait for another 60 seconds for the AHRS500GA-[] to re-initialize
15. Turn OFF the MagAlign switch

### *6.2.3 Detailed Alignment Procedure*

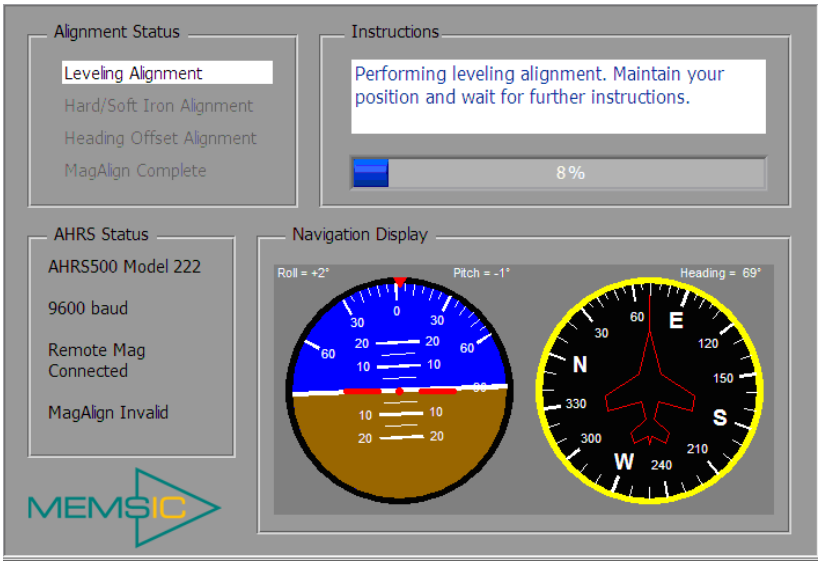
#### 6.2.3.1 Step 1: Leveling Alignment

The first step of the alignment process is Leveling Alignment to align the CRM500GA-[] with AHRS500GA-[]. To accomplish this:

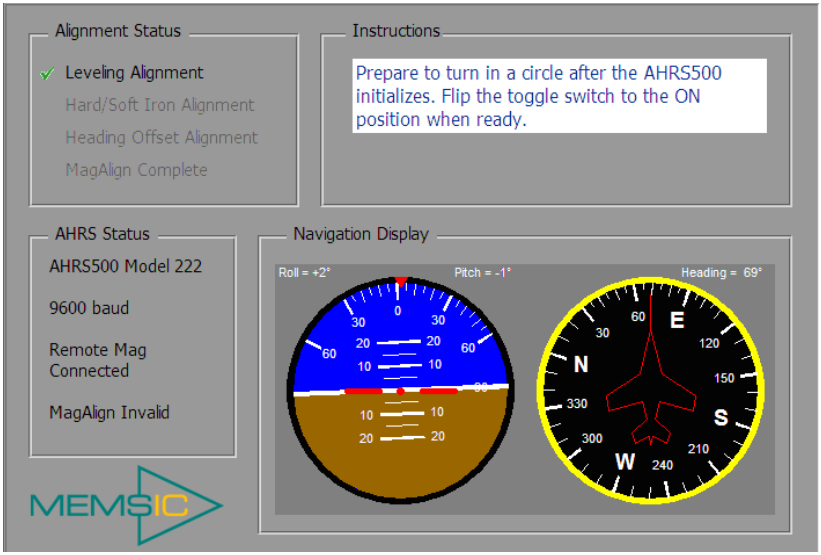
- First follow the instructions in Section 4.4.6.4.
- Once you have the MagAlign screen up, you should see instructions "Alignment is needed. Make sure that you are level, then flip the toggle switch to ON position to begin".




- Turn the MagAlign Switch to 'ON'.
- You should see the instructions change to "Performing Leveling Alignment. Maintain your position and wait for further instructions". You would also see the "Leveling Alignment" highlighted in the Alignment Status box as shown below.



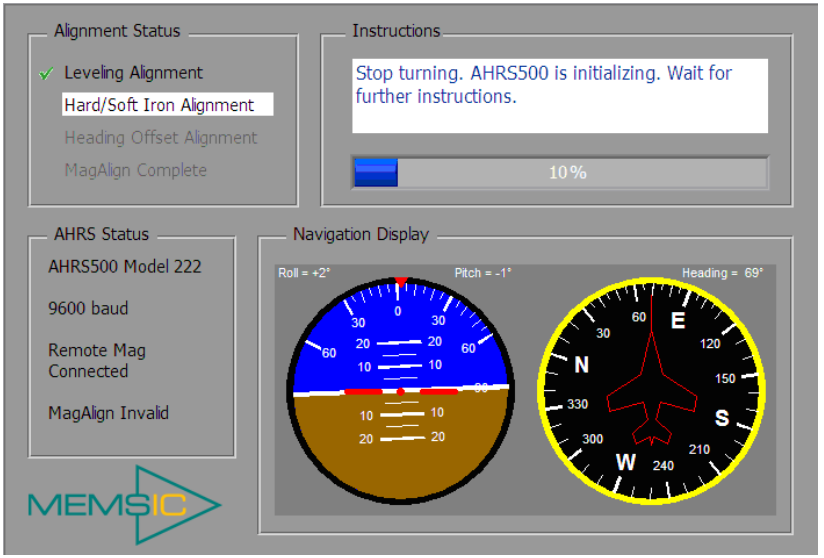

- Maintain the aircraft in this position motionless for 60 seconds.
- Upon completion the instructions should change to “Leveling Alignment successful. Flip the toggle switch to OFF position”.
- Turn the MagAlign Switch to ‘OFF’. You should also notice Check mark on “Leveling Alignment” in the Alignment Status box indicating the success.




### 6.2.3.2 Step 2: Hard and Soft Iron Alignment

This alignment routine requires, turning the aircraft through several rotations to compensate for hard/soft iron effects. To accomplish this:

- Upon completion of Step 1, you should see the MagAlign screen as shown above with instructions box indicating “Prepare to turn in a circle after the AHRS500 initializes. Flip the toggle switch to the ON position when ready”.
- Turn the MagAlign Switch to ‘ON’.
- The instructions box will change to “Stop turning. AHRS500 is initializing. Wait for further instructions”. You would also see the “Hard/Soft Iron Alignment” highlighted in the Alignment Status box as shown below.




- Wait for 60 seconds for the AHRS500GA-[] to initialize. The Progress bar will indicate the percentage of initialization that has been completed.
- Upon completion of the initialization, the message box will change to “Hard/Soft iron alignment needs refinement. Turn slowly in a circle until instructed to stop”.
- Turn the aircraft in a circle slowly. Although it does not matter if the aircraft turns clockwise or counter-clockwise direction in any of the turns, it is preferable to turn in only one direction. The turn will continue through 360 degrees.
- Upon completion of the turn the instructions box will change to “Stop turning. AHRS500 is initializing. Wait for further instructions”.
- Wait for 60 seconds for the AHRS500GA-[] to initialize. The Progress bar will indicate the percentage of initialization that has been completed.
- In general, a successful magnetometer alignment may require several turns in a circle before the program declares the hard/soft iron alignment is successful. The message in the MagAlign Message Box will tell the user if additional turns in a circle are required. The same process of turning through 360 degrees (full

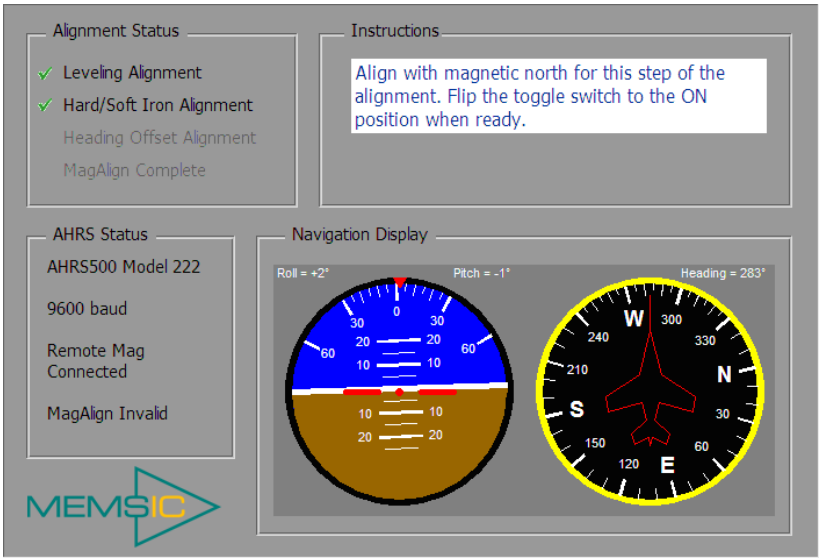
circle) and a wait of 60 seconds for initialization will be required for each turn.

- When you have a successful hard/soft iron alignment, the instructions box should read “Hard/soft iron alignment is successful. Flip the toggle the switch to the OFF position”.
- Turn the MagAlign Switch to ‘OFF’. You should now notice Check mark on “Hard/Soft Iron Alignment” in the Alignment Status box indicating the success.

#### 6.2.3.3 Step 3: Heading Offset Alignment

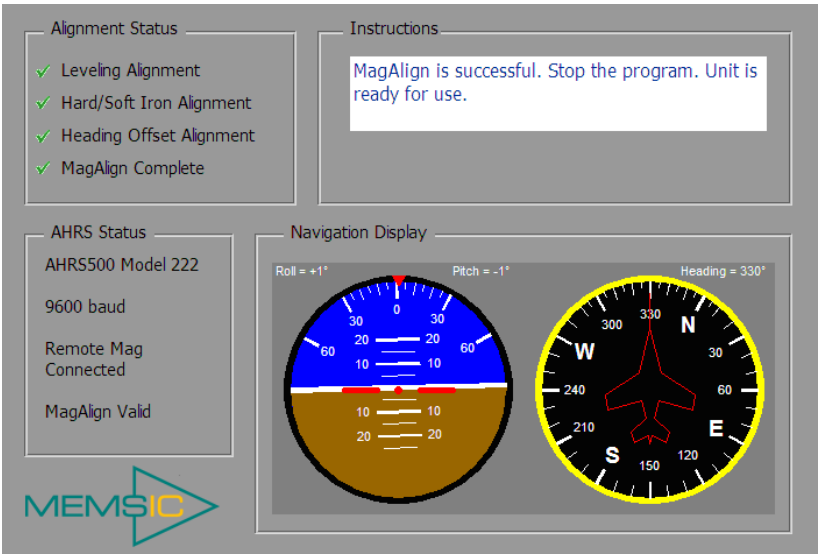
This step requires the aircraft to be oriented along the magnetic North for heading alignment of the CRM500GA-[]. This can be done easily by using a known reference marker such as a compass, compass rose, or runway with known heading. To accomplish this:

- Upon completion of Step 2, you should see the MagAlign screen as shown below with instructions box indicating “Align with magnetic north for this step of the alignment. Flip the toggle switch to the ON position when ready.”




- Align the aircraft along Magnetic North and turn the MagAlign Switch to ‘ON’.

- The instructions box will change to “Performing heading offset alignment. Maintain your position and wait for further instructions”.
- Maintain the aircraft in this position motionless for 60 seconds. Progress bar will indicate the percentage of initialization that has been completed.
- Upon completion, the instructions box will change to “Heading offset alignment is successful and AHRS500 is initializing. Wait for further instructions”.
- Maintain the aircraft in this position for 60 more seconds for the AHRS500GA-[] to initialize. Progress bar will indicate the percentage of initialization that has been completed.
- Upon completion of initialization, instructions box will change to “AHRS500 has finished initializing. Flip the toggle switch to the OFF position to continue”.
- Turn the MagAlign Switch to ‘OFF’.
- The message will change to “Alignment is successful. Stop the program. Unit is ready for use”. You should also notice Check marks on “Heading Offset Alignment” and “MagAlign Complete” in the Alignment Status box indicating the success.




- To stop the program, exit the application.

The AHRS500GA-[] and CRM500GA-[] are now ready for use. Remove the Test Cable and restore all the connections to the aircraft connector.

## 6.3 Testing the CRM500GA-[] Alignment

### *6.3.1 Heading Alignment*

The heading alignment can be tested by comparing the heading output of the CRM500GA-[] (or AHRS500GA-[]) on the primary flight display against a known reference such as a compass, compass rose, or runway with known heading.

Align the aircraft along an ordinal heading of North, South, East or West. Make sure the CRM500GA-[] (or AHRS500GA-[]) has completed the 90 second initialization period. Observe the heading reading on the MagAlign software. Make sure heading reading agrees within $4^0$ of the reference. Rotate the aircraft along an ordinal heading of North, South, East or West that is 90 degrees from the previous position. Observe the heading reading on the MagAlign software and make sure that this agrees within $4^0$ from the reference. A good alignment will not display more than a $4^0$ heading change once the turning is stopped. Repeat this test for all the four ordinal heading directions.

Significant errors in the CRM500GA-[] heading alignment indicate improper alignment or improper operation of the CRM500GA-[]. If the heading errors are greater than $4^0$, go back to section 6.2.3 and repeat the MagAlign procedure until a satisfactory heading performance is obtained.

# 7 Support Information

## 7.1 Customer Service

As a MEMSIC customer you have access to product support services, which include:

- Single-point return service
- Web-based support service
- Same day troubleshooting assistance
- Worldwide MEMSIC representation
- Onsite and factory training available
- Preventative maintenance and repair programs
- Installation assistance available

## 7.2 Contact Directory

United States: Phone: 1-408-965-3300 (8 AM to 5 PM PST)
Fax: 1-408-324-4840 (24 hours)
Email: techsupportca@memsic.com

Non-U.S.: Refer to website www.memsic.com.

## 7.3 Return Procedure

### *7.3.1 Authorization*

Before returning any equipment, please contact MEMSIC to obtain a Returned Material Authorization number (RMA).

Be ready to provide the following information when requesting a RMA:

- Name
- Address
- Telephone, Fax, Email
- Equipment Model Number
- Equipment Serial Number
- Installation Date
- Failure Date
- Fault Description

### 7.3.2 Identification and Protection

If the equipment is to be shipped to MEMSIC for service or repair, please attach a tag TO THE EQUIPMENT, as well as the shipping container(s), identifying the owner. Also indicate the service or repair required, the problems encountered, and any other information considered valuable to the service facility such as the list of information provided to request the RMA number.

Place the equipment in the original shipping container(s), making sure there is adequate packing around all sides of the equipment. If the original shipping containers were discarded, use heavy boxes with adequate padding and protection.

### 7.3.3 Sealing the Container

Seal the shipping container(s) with heavy tape or metal bands strong enough to handle the weight of the equipment and the container.

### 7.3.4 Marking

Please write the words, "***FRAGILE, DELICATE INSTRUMENT***" in several places on the outside of the shipping container(s). In all correspondence, please refer to the equipment by the model number, the serial number, and the RMA number.

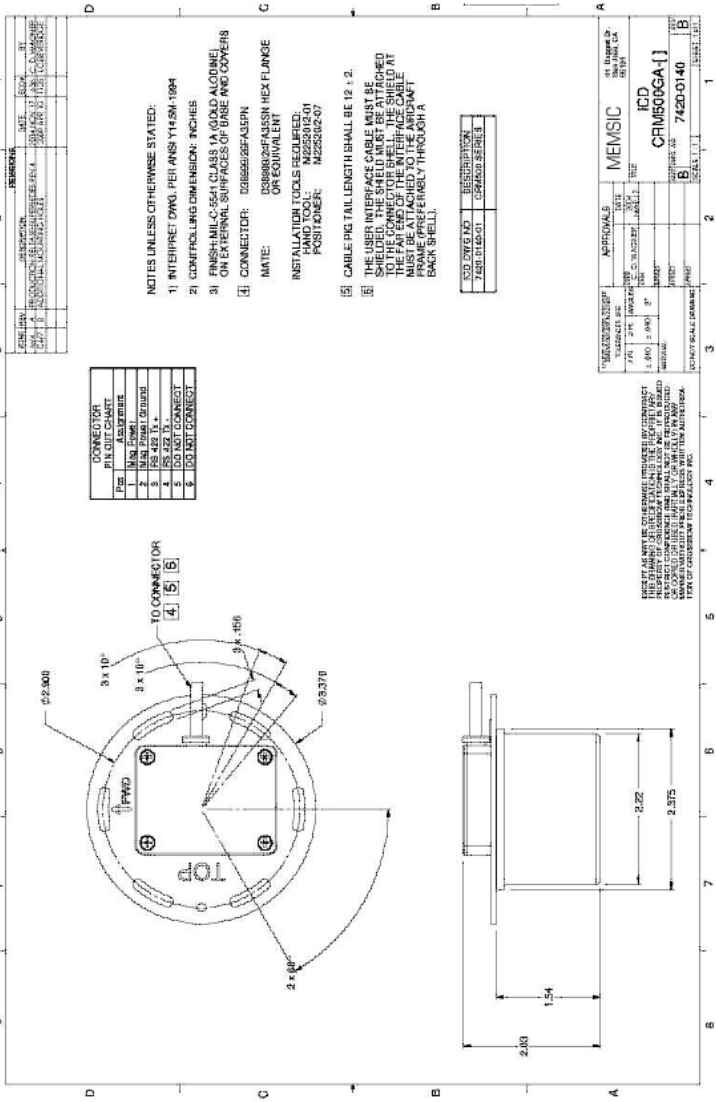
### 7.3.5 Return Shipping Address

Use the following address for all returned products:

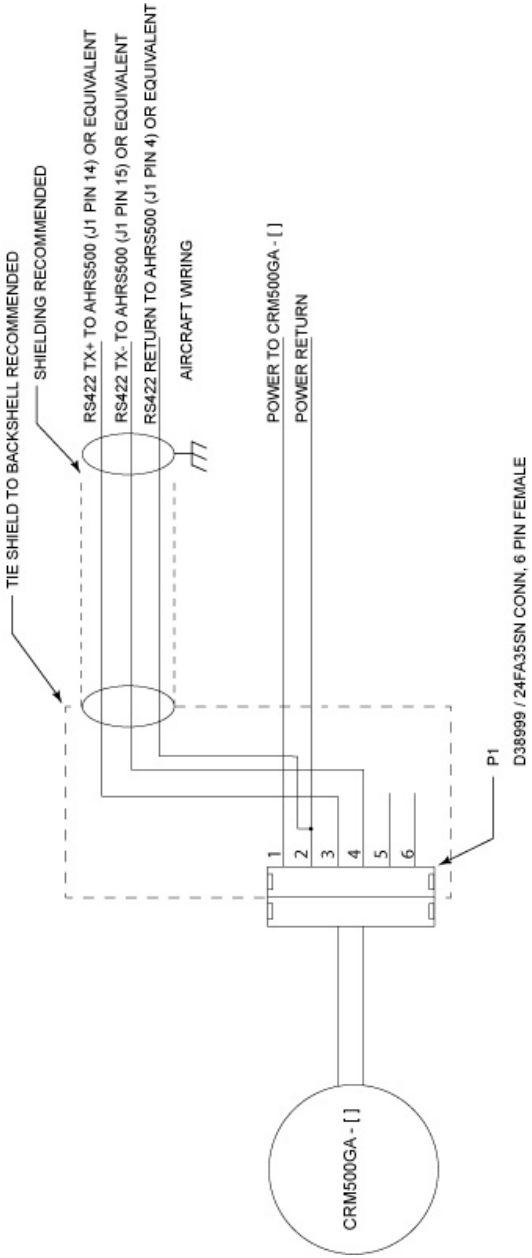
MEMSIC, Inc.
1759 McCarthy Blvd
Milpitas, CA 95035
Attn: RMA Number (XXXX)

# 8 Appendices

## 8.1 Installation Drawing



## 8.2 Installation Wiring Diagram



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